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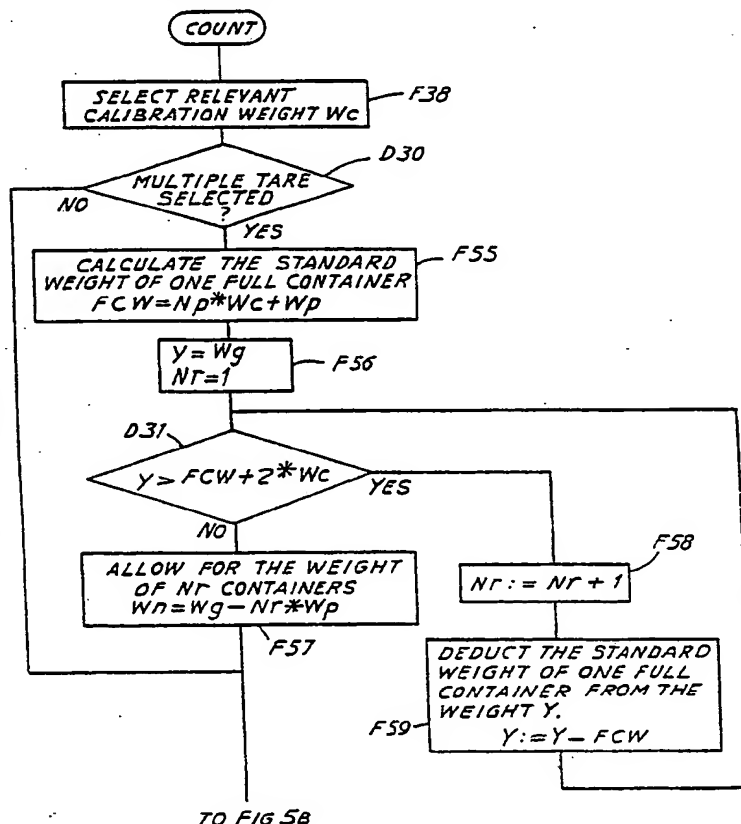
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| (51) International Patent Classification ⁵ : G01G 19/42, 23/16 | A1 | (11) International Publication Number: WO 90/01683 (43) International Publication Date: 22 February 1990 (22.02.90) |
| <p>(21) International Application Number: PCT/GB89/00912</p> <p>(22) International Filing Date: 9 August 1989 (09.08.89)</p> <p>(30) Priority data: 8818951.9 10 August 1988 (10.08.88) GB</p> <p>(71) Applicant (for all designated States except US): PERCELL GROUP LIMITED [GB/GB]; Leeway, Newport, Gwent NP9 0SL (GB).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only) : LARE, Christopher [GB/GB]; 12 Ger-Y-Sedd, Bridgend, West Glamorgan CF31 2LB (GB).</p> <p>(74) Agent: NEEDLE, Jacqueline; W.H. Beck, Greener & Co., 7 Stone Buildings, Lincoln's Inn, London WC2A 3SZ (GB).</p> | | <p>(81) Designated States: DE, GB, JP, US.</p> <p>Published With international search report.</p> |

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(54) Title: **METHOD AND APPARATUS FOR DETERMINING THE NUMBER AND/OR VALUE OF WEIGHED PACKAGED ITEMS**

(57) Abstract

Weighing apparatus for weighing currency notes or coins has a weighing platform (4) coupled to a load cell (14) for generating a weight signal dependent upon the weight of items on the platform. The weighing machine includes a microprocessor (26) with associated memory (32, 34) which determines the number and/or value of the weighed items by dividing the weight signal by an appropriate weight factor. When a number of standard packages of items are placed on the weighing platform (4), the apparatus automatically calculates an appropriate tare allowance to deduct from said weight signal to form a nett weight signal from which the number and/or value of the weighed items is determined. The tare allowance is calculated by dividing the weight signal by a preset value, for example, representative of the weight of a single package, and then multiplying the quotient formed by a preset tare value representative of the weight of the packaging.



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METHOD AND APPARATUS FOR DETERMINING
THE NUMBER AND/OR VALUE OF WEIGHED PACKAGED ITEMS

05 The present invention relates to a method and
apparatus for determining the number and/or value of
weighed packaged items.

Many items are stored or sold in pre-wrapped
packages. Currency is often pre-wrapped in this way,
for example, notes are grouped together and held by a
10 band or clip, and coins are wrapped in a roll or
bagged. Small hardware items, such as screws and hooks
are also generally sold in packages.

There is frequently a need to ascertain the number
of individual items within a package, and in the case
15 of currency to determine the value of the items in that
package.

Counting machines for determining the number
and/or value of items such as coins or bank notes by
weighing are known. For example, European Patent No.
20 0040539 describes such a machine which determines the
number and/or value of the weighed items by dividing a
total weight signal by an appropriate weight factor.

However, before an accurate determination of the
number and/or value of the items in a package can be
25 made, the weight of the packaging needs to be taken
into account. This is done by determining the weight
of the packaging, recording this weight, "the tare
weight", and then subtracting the predetermined tare
weight from the total weight signal to form a nett
30 signal representative of the weight of the items
without the packaging. It is this nett signal which is
then divided by the weight factor to determine the
number or value of the items.

The present machines with a tare facility can only
35 determine the number and/or value of packaged items
where single packages are individually weighed, or

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where the packages are stacked successively and the total packaging weight does not exceed more than 0.5 of the weight of an item. However, such packages are often presented in bundles and it would be useful to be able to weigh the packages in their bundles.

According to a first aspect of the present invention there is provided apparatus for determining the number and/or value of items packaged in one or more packages, said apparatus comprising processor means arranged to receive a weight signal representative of the total weight of the packages, said processor means having means for calculating from said weight signal a tare allowance representative of the weight of the packaging of said packages, and means for subtracting the calculated tare allowance from said weight signal to form a nett weight signal representative of the weight of the items.

Apparatus of the invention is enabled to calculate a tare allowance from the weight signal. Thus a user can place a number of packages onto the apparatus which subtracts an appropriate tare allowance from the weight signal before evaluating the actual number of items.

In an embodiment, said means for calculating said tare allowance comprises means for dividing said weight signal by an appropriate preset value to form a quotient, and means for multiplying a preset tare value representative of the weight of the packaging by said quotient to form said tare allowance. For example, said quotient may be formed by repeatedly subtracting said preset value from said weight signal, and incrementing a counter for each said subtraction, until said weight signal is smaller than said preset value, and the contents of the counter then providing said quotient.

The preset value by which said weight signal is

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divided may be representative of the weight of the items in a single package or of the total weight of one package such that said quotient is at least approximately representative of the number of packages.

05 The preset tare value is then representative of the weight of the packaging of a single package.

The quotient formed may not be a complete integer. In these circumstances it may be utilised directly to form said tare allowance, or an appropriate exact integer therefor may be formed. This exact integer would then be utilised to form said tare allowance.

10 In an embodiment, said processor means further comprises means for dividing said nett weight signal by an appropriate weight factor to determine the number and/or value of said items. For example, said weight factor may be representative of the weight of the items in a single package, or said weight factor may be a calibrated value representative of the weight of a single item.

20 The present invention also extends to a weighing apparatus for determining the number and/or value of weighed items, said apparatus comprising means for producing a weight signal, and apparatus as defined above for determining the number and/or value of packaged items and arranged to receive said weight signal, wherein means are provided for determining the number and/or value of the weighed items from said nett weight signal.

30 Preferably, said means for determining the number and/or value of the weighed items comprises means for dividing said nett weight signal by an appropriate weight factor.

35 Preferably, said means for producing the weight signal comprises weighing means for producing an actual measured weight.

In an embodiment arranged to weigh items of

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different denominations, each denomination representing a different value, said weighing apparatus comprises storage means in which a list of denominations is stored together with the value assigned to each
05 denomination, and a respective weight factor for each denomination in said list, wherein each said weight factor is representative of the weight of a respective predetermined number of the items of that denomination.

10 Preferably, said processor means has means for dividing said nett weight signal by a selected weight factor to form a quotient representative of the number of items being weighed, and means for comparing said
15 quotient with tolerance limits, and output means for signalling that said quotient is within said tolerance limits and so acceptable or that said quotient is outside said tolerance limits and so unacceptable. In this case, said processor means is arranged to be responsive to said output means signalling that said
20 quotient is acceptable to enable multiplying means to multiply at least part of said quotient by the value assigned to said denomination whereby the value of the weighed items is determined. When said quotient is acceptable an appropriate exact integer value therefor
25 is formed, and it is said exact integer value which is multiplied by said multiplying means with said assigned value.

30 Preferably, the apparatus is for counting coins or notes and each weight factor corresponds to the weight of a respective number of coins or notes of a respective denomination.

35 According to a further aspect of the present invention there is provided a method of determining the number and/or value of items packaged in one or more packages, the method comprising the steps of calculating a tare allowance from a weight signal

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representative of the total weight of the packages, and subtracting the calculated tare allowance from said weight signal to form a nett weight signal representative of the weight of the items.

05 Preferably, said weight signal is divided by a preset value representative of the weight of said items to form a quotient, and a preset tare value representative of the weight of the packaging is multiplied by said quotient to form said tare
10 allowance.

Embodiments of the present invention will hereinafter be described, by way of example, with reference to the accompanying drawings, in which:

15 Figure 1 shows a perspective view of weighing apparatus of the invention,

Figure 2 shows a block circuit diagram of the apparatus of Figure 1,

20 Figure 3 shows a flow diagram of the main weighing routine performed by a processing unit of the weighing apparatus,

Figure 4 shows a flow diagram of a verifying routine of the weighing apparatus,

25 Figures 5A, 5B and 5C show a count routine of the weighing apparatus, and

Figures 6A, 6B and 6C together show a flow diagram of a key handling routine of the weighing apparatus.

30 The drawings illustrate a weighing apparatus for determining the number and/or value of weighed items. The weighing apparatus described and illustrated herein is generally similar to that described and illustrated in our International Application No. PCT/GB88/00391 (WO 88/09485) but is modified, as will become apparent, to
35 have a tare facility designed to make it unnecessary to weigh packaged items in single packages. The weighing

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apparatus, as is apparent from Figure 1, is a stand alone weighing machine having a housing generally referenced 2 in which an electronic circuit including processing means and electronic storage is contained. A
05 block diagram of the circuit of the machine is illustrated in Figure 2.

As shown in Figure 1 a weighing platform 4 for receiving items such as coins or notes whose number and/or value is to be determined is associated in known
10 manner with an electronic precision weighing device for the provision of electrical output signals which are proportional to the weight applied to the weighing platform 4. A number of input keys 5 to 11 are provided in a panel of the housing 2 for inputting
15 information to the processing unit. Furthermore, a display panel 12 for displaying appropriate messages under the control of the processing unit is also provided in a panel of the housing 2. Naturally, this display panel 12 may be constituted by appropriate
20 display means.

Figure 2 shows a block circuit diagram of the electronic circuit of the machine received within the housing 2. The weighing platform 4 is associated with a load cell 14 of the electronic precision weighing
25 device. This load cell 14 is supplied with a regulated power supply by way of a power supply regulator 16 connected across a battery 18. This load cell produces an electrical output signal whose magnitude depends upon the weight applied to the load cell by way of the
30 weighing platform 4. This output signal is fed to an amplifier 20, and the amplified output signal is then applied to an analogue to digital converter 22. It will be seen that the analogue to digital converter 22 is also fed with a regulated power supply from the
35 regulator 16. The power supply applied directly to the converter 22 acts as a reference so that the digital

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output signal from the converter 22 is generally independent of any fluctuations in power supply levels and therefore is substantially proportional to the weight applied to the load cell 14. In known manner, the power supplied to the electronic precision weighing device is isolated from the power supplied to the processing means to avoid problems with noise.

A further power output 24 of the regulator 16 is connected in known manner to provide power to a processing unit 26 and units associated therewith.

In the embodiment shown, the processing unit is a micro-processor 26 whose associated keyboard 28 is constituted by the keys 5 to 11. A display 30 of the micro-processor 26 is constituted by the display panel 12 together with appropriate display drivers and interface means (not shown). In the embodiment illustrated, the micro-processor 26 is connected both to a pre-programmed memory 32 which may be a read only memory (ROM) or a programmable read only memory (PROM), and to a memory 34 which is a random access memory (RAM). The pre-programmed memory 32 includes the programs for the micro-processor 26 as well as data relating to the items which the weighing machine is arranged to weigh.

The machine is described below as a machine arranged for weighing bank notes and/or coins and/or tokens or other counters representative of monetary value. However, it should be noted that the machine can be used for the weighing or counting of items other than those having a monetary value. For simplicity, in the following description, we will consider the operation of the machine as a currency counter programmed to be responsive to the notes and coins of a single currency, although the machine may be programmed to weigh the notes and coins of more than one currency.

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The information held in the memory 32 includes a list of the denominations of the notes and coins of the currency of interest. In addition, the memory 32 includes the monetary value of each denomination.

05 There is also stored within the memory 32 weight limits below which the weighing platform is deemed to be empty, and weight limits below which the weighing platform is deemed to be empty and zero tracking will occur.

10 The memory 32 also contains the weight of each denomination of the coins and notes. In addition for each denomination of notes, the memory contains the following information: an Error Band Table providing predetermined error band limits for each note dependent
15 upon the number of notes being counted; the maximum number of each note which may be counted in any single operation; and the largest number of notes which may be placed on the scale pan before a warning message is displayed.

20 This latter information is utilised in error reduction techniques described hereinbelow, which are also described in our copending application No. PCT/GB89/00630. It would be possible to store the same information in respect of the coins of the currency.
25 Generally, however, the weight of coins is very stable and they can be counted and/or valued very accurately simply by weighing and without any calibration or error reduction techniques being necessary.

30 The memory 32 includes the monetary value of each denomination, and in addition stores:

1. The weight of a single item of each denomination.
2. The weight of the packaging of a single
35 package of such items.
3. The number of items which would be wrapped in

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a single package.

The use of all of the information pre-programmed into the memory 32 will become apparent from a
05 consideration of the program routines illustrated by the flow diagrams of Figures 3 to 6 which are described below.

It will be appreciated that the information in the memory 32 is generally programmed in the factory.

10 However, the programming of the memory 32 is not within the scope of this invention and will not therefore be further described.

When the machine of Figure 2 is switched on, the micro-processor 26 is programmed to initiate any
15 initialisation routines. On first switch on, this involves the transfer of certain information from the memory 32 to the RAM 34. It will be seen that the RAM 34 is permanently supplied with standby power by way of the regulator 16 so that the RAM is not volatile.

20 Generally, it is the information in the RAM 34 which is utilised by the micro-processor 26 in the performance of the programs. This enables the information stored in the RAM 34 to be updated as necessary. In addition, full calibration and partial recalibration programs,
25 which are not described herein, may be provided to modify the information stored in the RAM 34.

When the machine of Figure 2 is on, the micro-processor 26 runs its main program continuously. This program is the weighing routine shown in Figure 3.
30 In addition, the weighing device is arranged by way of micro-processor timing means to periodically supply a weight signal to the micro-processor 26. For example, a new weight reading can be supplied ten times a second.

35 The micro-processor 26 is also programmed to

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continuously run a keyboard read routine causing the state of the keys 5 to 11 of the keyboard 28 to be read periodically. This information as to key states is stored in appropriate locations of the RAM 34. For example, in a preferred embodiment, the keyboard is read once every four milliseconds and the keyboard map showing which keys are currently pressed is stored in RAM 34. In known manner, the keyboard read routine is provided with anti-bounce checks.

The provision of a suitable keyboard read routine and of a timing means for periodically supplying weight signals will be within the competence of anyone skilled in the art and so are not further described herein.

Figure 3 shows the flow chart for the main weighing routine and it will be seen that the first action taken is the running of a key handling routine F1. This routine, which is illustrated in Figure 6, looks at the keyboard map stored in RAM showing the state of the keys 5 - 11 and selects appropriate modes in accordance with the keys which have been pressed. Let us assume that initially no keys are pressed.

The exits of the key handling routine F1 return to the main routine of Figure 3 which proceeds to determine if a new, filtered, weight reading Wr has been received from the weighing device by way of the converter 22. In this respect, it will be recalled that weight readings are applied to the micro-processor 26 ten times a second. It will be clear from Figure 3 that if the decision at block D1 is made when no new weight reading has arrived, the program will loop back to decision D1. If a filtered weight reading Wr is received, that new weight reading will be stored in RAM 34 and the program will then move on to function F2. In this respect, the program at decision block D1 is arranged to determine not only that a new weight reading has been received, but also that the weight

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reading has settled and has been filtered to remove the effects of vibration. Thus, at the decision block D1 the program effectively waits for a new, steady and filtered weight reading W_r to be received.

05 Stored in RAM 34 is a pan empty reading W_z which is representative of the weight signal received when the weighing platform 4 is empty. At block F2 the gross weight W_g on the platform 4 is determined by subtracting the pan empty weight W_z from the current
10 weight reading W_r that is, $W_g = W_r - W_z$. This determined gross weight W_g is stored in RAM.

 The routine then moves on to the decision block D2 where it determines if single tare has been selected, for example, by pressing the appropriate key 5, marked
15 "T". This information will already have been stored in RAM by the key handling routine F1. If single tare has been selected function block F3 subtracts from the gross weight W_g the tare weight W_t stored in RAM to form the nett weight W_n , that is
20

$$W_n = W_g - W_t.$$

 In this case, the key handling routine F1 will have already determined that none of the keys 5 to 11
25 has been pressed and accordingly the answer at the decision block D2 is "No". This leads the routine to block F4 in which the nett weight W_n is accorded the value of the gross weight W_g .

 The nett weight W_n formed by either function F3 or
30 F4, as appropriate, is then applied to decision block D3 where it is compared with zero track limits from the memory 32. These zero track limits give the readings below which the weighing platform is deemed to be empty. These zero track limits also set the readings
35 below which adjustment of the stored pan empty reading occurs.

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By way of example, let us assume that the stored pan empty reading Wz is 200. Let us also assume that the weighing platform 4 is empty and that the weight reading Wr received by the micro-processor 26 is 203.

05 It will be apparent that the gross weight Wg computed by function F2 will be 3 and this will be assigned to the nett weight Wn by block F4. If the zero track limits are set say at 8, the nett weight Wn will be found by block D3 to be less than the limit. The "YES"

10 answer at decision block D3 will therefore cause zero tracking to be performed by the function block F5.

In function block F5 a new pan empty reading Wz is computed from the original Wz reading and from the new weight reading Wr. The formula used is

15

$$\text{New Wz} = \text{Old Wz} \times 0.95 + \text{Wr} \times 0.05.$$

It will be appreciated that this formula causes a gentle adjustment to the original value of Wz to be made because the new value of Wz is strongly based on the old value with only a 5% adjustment for the new weight reading Wr. In the example given the adjusted value which is assigned to Wz in RAM will be 200.15 as compared to the 200 originally assigned thereto. By

20 this means it is ensured that the value of Wz only undergoes considerable alteration in response to a trend, and that it is not adversely effected by spurious readings.

The pan empty reading Wz having been adjusted by block F5, the program moves on to decision block D4 in which the nett weight Wn is compared with pan empty limits stored in ROM 32. These are the weight limits below which the weighing platform is deemed to be empty. In the example given, these limits might be

30 set, say, at 15. In the example given, the nett weight Wn has been accorded the value 3 and therefore

35

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is well below the pan empty limits so that D4 gives a "YES" output. The routine has therefore correctly identified that the pan is empty and function block F6 thereby causes an appropriate pan empty message to be displayed by way of the display 30. Block F6A now sets an "OKTOADD" flag which is used later in the key handling routine at block D20, and block F6B resets to zero variables which are used in the COUNT routine of Figures 5A, 5B and 5C. At this point, as will be appreciated, the routine loops back to its start and thus can respond at F1 to any keys which have been pressed and at D1 to the receipt of a new weight reading.

If on running through the weighing routine of Figure 3 it is found that a weight has been placed on the platform 4, it will be appreciated that the nett weight W_n computed at either F3 or F4 will be more than the zero track limits of D3 and the pan empty limits of D4. In this case then, instead of looping back to the start, the routine will continue to decision block D5 in which the program looks to see which mode has been selected. If the key 6 marked "V" has been pressed the verify mode will have been selected and the verify program of Figure 4 will be run. Alternatively, if either of the keys 10 or 11, marked respectively "NOTES" and "COINS", have been pressed, the program will proceed to its count routine illustrated in Figures 5A, 5B and 5C.

Figure 4 illustrates the verifying routine which enables automatic verifying of standard packs of notes or coins. Initiation of this routine is by pressing the key 6. With this key pressed, and the weighing platform 4 empty, the verify mode is selected by the key handling routine F1, and the function block F6 of the main program will cause the message "VERIFY" to be displayed by the display 12. Thereafter, the placing

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of a weight on the platform 4 will cause the machine automatically either to confirm the contents of the pack or to display a warning message "CHECK IT".

05 To perform the verify routine of Figure 4,
additional information in the form of a list of the
denominations of coins and notes which can be verified
by the machine is stored in memory 32. As noted
previously, for each denomination there is also stored
10 a calibration weight W_c for that denomination, the
number N_v of items of that denomination in a standard
pack, and the tare weight W_t , that is, the weight of
the packaging for that standard pack. If the coins or
notes of any denomination are often packaged in more
15 than one standard pack, that denomination may appear
more than once in the list of denominations. Each
entry for each denomination will, in this case be
associated with data (N_v and W_t) relating to a
respective standard pack.

20 The verifying routine is described and illustrated
in International Application No. W0 88/09485, the
contents of which are incorporated herein by reference.
Accordingly, the details of the routine, which is
illustrated in Figure 4, will not be further described
herein.

25 As is also made clear in International Application
No. W0 88/09485, the machine is particularly useful in
that the standard packs placed on the platform 4 for
their verification, can simultaneously have their
values added. Thus, at the end of a verification run,
30 the operator will not only have checked the accuracy
and integrity of the contents of a series of standard
packs, but will also have an accurate total of their
value. This addition is performed by the key handling
routine of Figures 6A, 6B and 6C which is initiated by
35 function F1 of the main program. The addition
performed by the key handling routine is described in

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detail in International Application No. WO 88/09485 and so is not further described in detail herein.

05 The machine has various tare facilities, including a "multiple tare" facility enabling packaged items, for example, bags or rolls of coins to be weighed singly. The appropriate tare facility is selected by the key handling routine of Figures 6A, 6B and 6C which will now be described.

10 It will be recalled that the key handling routine illustrated in Figures 6A, 6B and 6C is initiated by function F1 of the main program. Its first step is to look at the map of pressed keys stored in RAM. The first decision block D8 then determines if the key 10, labelled "NOTES" is the only key pressed. If the key 15 10 has not been pressed, or has been pressed but in conjunction with other keys, the key handling routine continues along the route marked "NO" to consider the status of the other keys. If the output of block D8 is "YES" the program proceeds to block D9 which determines 20 if the platform 4 is empty, this information being available from the function block F6 of the main program. If the platform is not empty, for example because a previous count or verifying routine is being completed, the routine exits through "EXIT 1", clearing 25 the map of pressed keys stored in RAM before returning to the start of the main program of Figure 3. If the key 10 is pressed with the platform 4 empty, the key handling routine by way of blocks D8, D9 and D10 will select the count mode and enter that selection in RAM. 30 It will be seen that the function block F17 also selects "notes", selects the first denomination of notes in the list of denominations stored in RAM, and selects "loose notes". The denomination so selected will be displayed on the panel 12 and the other 35 selections can similarly be displayed. This routine then exits by way of "EXIT 1" and a function block F20,

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which clears the stored key map, to the main program.

05 If the denomination selected by the block F17 is
the denomination in which it is required to count, a
count routine can then be initiated simply by placing
the notes to be counted on the platform 4. However, if
the block F17 has selected a denomination which is not
required, the "NOTES" key 10 is repeatedly pressed and
released until the denomination required has been
selected and is displayed. It will be appreciated that
10 every time the key 10 is pressed with the count notes
mode already selected, the decision block D10 of the
key handling routine will cause by way of a decision
block D11 and function blocks F18 and F19 the selection
of a different denomination in the list. Each selected
15 denomination is displayed and so the operator continues
to press and release the key 10 until the appropriate
denomination is displayed. The count routine can then
be commenced by placing the notes on the platform 4.

20 The key handling routine includes an analogous
routine for selecting the count mode and the
denomination when coins are to be counted. This
routine is accessed by pressing only the key 11,
labelled "COINS", as is indicated by the decision block
D8c. The remaining decisions and functions of the coin
25 count routine have been given references the same as
those of the note count routine with the addition "C".
Each decision or function block of the coin count
routine performs a similar function or makes a similar
decision as the corresponding block in the notes count
30 routine. However, it will be seen that the function
block 17c which selects coins, count mode, and the
first denomination also selects "Bag Mode" which is the
multiple tare facility.

35 If both the "NOTES" key 10 and the key 5 marked
"T" are pressed together a decision block D12 leads to
a function block F21 which selects a full calibration

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mode. This mode, which enables the information stored in RAM to be calibrated will not be described herein. Similarly, pressing both the "COINS" key 11 and the key 5 causes a decision block D13 to proceed to a function block F22 which selects a recalibration mode. This mode enables calibration of selected information in RAM and again will not be further described herein.

If the key 5 marked "T" is pressed alone decision block D14 (Figure 6C) leads into a tare select mode.

In this mode, if block D15 finds the platform is not empty a manual tare routine is initiated to enable the weight of a container or wrapper to be measured and recorded before the weighing routine is commenced. In this manual mode, the container is placed on the platform 4 before the key 5 "T" is pressed. Because the platform is not empty decision block D15 leads to a set manual tare sub-routine in which the contents of the platform are weighed, F24, this weight Wt is stored in RAM as the tare weight, F25, and then manual tare mode is selected, F26. When a weighing routine is subsequently performed by the main program the tare weight Wt which has been stored will be subtracted from the gross weight Wg at function block F3, but this will be the tare weight established by functions F24 and F25.

If in the tare select mode, the decision block D15 finds that the platform 4 is empty, the routine moves to decision block D15A to establish if notes or coins have been selected. It will be recalled that this was set by function block F17 or F17C when an appropriate count mode and denomination was selected. If notes has been selected at function block F17, "loose notes", that is a count routine without a tare facility, will also have been selected. The decision at decision block D15B will therefore be "NO" causing function

block F23A to respond to the fact that the key 5 "T" has been pressed to select stored tare mode. It has already been seen that in the main program this causes the tare weight Wt to be subtracted from the gross weight Wg. It will be appreciated that if the key "5" marked "T" is not pressed after a notes count routine, and the appropriate denomination have been selected, function block F17 will have selected "loose notes", that is a count routine without a tare facility so that function block F4 of the main program sets the nett weight Wn equal to the gross weight Wg.

The decision block D15B enables the selection of the stored tare mode to be cancelled by pressing the key 5 "T" a second time so that the decision "Yes" at decision block D15B causes the function block F23B to clear all tares. It will be appreciated that pressing the key 5 repeatedly with the platform empty will cause the stored tare and loose notes modes to be selected alternately.

Where coins have been selected by function block F17C "Bag Mode" is automatically selected. We have seen that this can be changed to the manual tare mode by pressing the key 5 "T" with a coin tray or other container on the platform 4. If the tare mode needs to be changed from the manual tare mode selected back to "Bag Mode" this is achieved by pressing the key "T" with the platform empty so that function block F23C selects the "Bag Mode".

The other routines of the key handling routine illustrated in Figures 6A, 6B and 6C are described in detail in International Application No. WO 88/09485 and so are not further described herein.

As will be apparent from the descriptions given above, the machine has a normal count routine by which it is able to determine the number of notes or coins of

a selected denomination which have been placed on the platform 4. This count routine, which is illustrated in Figures 5A, 5B and 5C, enables the value of the items on the platform 4 to be determined whether the items are packaged or not. Function block F36 selects the weight W_c in RAM calibrated for the particular denomination which is being counted. At decision block D30 it is then decided if multiple tare has been selected, this being the "Bag Mode" of function blocks F17C and F23C. If the multiple tare facility has not been selected, the routine moves on to function block F37 at which the number of items on the platform 4 is determined by dividing the nett weight by the calibration weight, that is

$$N = W_n \div W_c.$$

It will be appreciated that the nett weight W_n has already been determined at function block F3 or F4 of the main weighing routine of Figure 3. In this respect, if either manual tare mode or stored tare mode has been selected, decision block D2 causes function block F3 to calculate the nett weight by subtracting the appropriate tare weight.

The routine then proceeds to block D25 to determine whether notes or coins are being counted. This, together with the denomination being counted, has already been selected by the operator, who has pressed either the "NOTES" key 10 or the "COINS" key 11 at the start of a weighing process. If coins are being counted the routine passes to function block F38 where the calculated number N of items on the pan is rounded to the nearest integer N_d . For example, if N is calculated at block F37 to be 23.87, then N_d is set to 24. At the subsequent function block F39 the value V

- 20 -

of the coins on the pan is calculated by multiplying the integer number Nd of coins on the pan by the denomination of those coins. For example, if the selected denomination is 20 pence coins, the value V will be 24 x 0.2 pounds, i.e. £4.80. Function block F40 then causes a suitable display of the determined value V, preferably with the selected denomination, to be made on the display panel 12. With the example given, the display might read "20p, £4.80". The routine then returns to the START of the main weighing routine of Figure 3.

If at decision block D25 of the count routine it is determined that notes are being counted, the routine passes to block F41 where Na, the number Na of notes added this time is calculated. In this respect, Na is determined by subtracting from the number of notes N determined at block F37 as being on the pan a number No. This number No was the number of notes calculated at block F37 during the immediately preceding pass through the count routine and stored. Thus,

$$Na = | N - No |$$

At function block F42 the number Na of notes added is rounded to the nearest integer Na'. At decision block D26 the routine determines if any notes have been added to the pan since the last pass through the routine by asking is Na' greater than zero? If Na' is equal to zero then no further notes have been added and the routine returns to the START of the main weighing routine of Figure 3, and makes no changes to the display.

If notes have been added, Na' will be greater than zero. When this is determined at decision block D26, the routine moves onto decision block D27 which

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determines if the number of notes added exceeds a preselected maximum number. In the illustrated embodiment, this maximum number has been chosen to be twenty-five which has been found to represent a good compromise between the requirement of accepting as many notes as possible, and the requirement of not displaying an incorrect result. Other numbers can be chosen to produce differing compromises of the above requirements without affecting the procedure. If N_a' , the rounded number of notes added, is greater than 25 then a warning message TRY LESS is caused to be displayed at block F45 and the routine returns to the START of the main weighing routine of Figure 3.

If it is determined at the decision block D27 that 25 or less notes have been added, the routine passes to function block F43 at which appropriate error band limits for the rounding are selected. In the particular embodiment illustrated, the rounded integer N_a' is used to select a particular set of error band limits from an Error Band Table which is stored within the memory 32. The error band limit range is generally decreased as the integer N_a' increases as explained in more detail in our copending application No. PCT/GB89/00630.

At block D28 the fractional part of N_a , the number of notes added, is compared with the limits determined at block F43. If the fractional part of N_a is within the error band limits then the result is in error and is not acceptable and a warning message TRY LESS is arranged to be displayed by the block F45 and then the routine returns to the START of the main weighing routine of Figure 3.

If at block D28 the fractional part of N_a is outside the error band limits, the result is acceptable and the routine passes on to block F44 to commence a

stacking error correction arranged to remove cumulative errors from the weighing of successive additions of notes.

05 The stacking error correction routine is similar
to that described and illustrated in our UK patent No.
2076979 and removes the risks of cumulative errors
occurring because the notes are being weighed in
successive bundles. To explain the operation, assume
10 that each item to be weighed has a calibrated weight of
10 grams, but an actual weight of 10.15 grams. A first
bundle of 25 items will weigh 253.75 grams, and the
resultant quotient N of 25.375 will be correctly
rounded to 25. A second bundle of 25 items placed on
15 the first will successfully meet the error band
criteria of decision block D28, but the cumulative
weight of 507.50 grams, and the resultant quotient of
50.75 would be incorrectly rounded to 51.

20 This sort of error is obviated by the stacking
error correction routine. At function block F44 a
stacking correction factor G is subtracted from the
quotient N representing the total number of notes
calculated at block F37. By this means a corrected
number Nc of items on the pan is formed, where

25
$$N_c = N - G.$$

Initially, as we saw in the main weighing routine of
Figure 3, the stacking correction factor G is zero.

30 The corrected number Nc is then rounded to the
nearest integer Nd at function block F46. It will be
appreciated that Nd represents the total number of
items on the pan.

35 The routine next passes to function block F47
where a new stacking correction factor G is calculated
as the difference between the corrected integer number

of notes on the pan, Nd, and the calculated number N of notes on the pan from block F37.

i.e. $G = N - Nd$

05

The new stacking correction factor G having been stored, the routine passes to block F48 where the value V of the notes of the pan is calculated by multiplying the number of notes on the pan by their denomination.

10 That is:

$$V = Nd \times \text{denomination}$$

15 This calculated value V is then caused to be suitably displayed on the display panel 12 by way of function block F49. In this respect, the display could be of value only or of denomination and value, for example, the display could be "£5, £250".

20 The routine then performs an updating of the calibrated weight Wc, and the new value for Wc is stored in RAM in place of the old value. The updating is performed at function block F50 and is arranged to modify the calibration weight Wc of the selected denomination in such a way as to reduce the difference
25 between the stored calibration weight Wc and the real average weight of the notes being counted. In the embodiment illustrated the new value for Wc is calculated according to the formula:

30 $\text{New } Wc = \text{Old } Wc (1 - 0.0005Na') + (Wn - Wo) 0.0005$

Where Wn is the nett weight on the pan, and Wo is the old nett weight on the pan, that is the nett weight at the immediately preceding pass through the count
35 routine of Figures 5A, 5B and 5C.

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It will be seen that this formula takes account of the number of notes added each time as well as their average weight. The effect of thus modifying the calibration weight is to enable the machine to track slow changes in the average weight of the notes being counted. In this respect, it will be appreciated that it is important to continuously update the stored weight W_c for notes because notes can vary significantly in their weight depending upon whether they are old or new, if they have been damaged, or subject to humidity and the like. It would be possible to recalibrate the weight reading stored for the coins, but this is not generally necessary.

At block F51 the old number of notes on the pan, N_o , is updated to be the current number of notes on the pan and at block F52 the old weight on the pan, W_o , is updated to be the current weight on the pan and then the routine returns to the START of the main weighing routine shown in Figure 3.

We have already seen that a multiple tare facility may be selected at function blocks F17C and F23C of the key handling routine. If this facility is selected a routine which automatically determines the number of containers in which coins are packaged so that these containers can be allowed as a tare weight is initiated by the decision block D30.

In the embodiment of the multiple tare facility particularly described and illustrated the following assumptions are made:

1. When using the multiple tare facility, the coins will be put onto the platform 4 in nominally full containers and there will be no loose coins.
2. Containers will not be overfilled by more than

- 25 -

two coins, and any excess over the standard quantity will be in a separate container.

Thus if a nominally full container contains 20 coins and the machine determines that there are 124 coins, the machine will determine that there are 6 full containers of 20 coins and a seventh container of 4 coins.

Of course, other assumptions may be made if required. For example, it could alternatively be assumed that all odd coins are loose rather than being in a further container.

If the multiple tare facility has been selected a "YES" at decision block D30 moves the routine to function block F55 which is at the commencement of an iterative process to calculate the tare weight to be allowed for the containers. Block F55 calculates the standard weight FCW of one container or packaging for the standard pack of the selected denominated. As shown, the weight FCW is calculated by multiplying the standard number of items per pack N_p by the weight W_c of each item and then adding the weight W_p of the empty container or packaging, that is:

$$FCW = N_p \times W_c + W_p$$

The routine then passes to function block F56 where a variable y is equated to the gross weight W_g and a counter for the number of containers N_r is set to 1. The routine then passes onto decision block D31 which compares the weight y with the standard weight FCW of one container plus the weight of two items. Thus, at decision block D31 the following question is asked:

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 $y > FCW + 2Wc?$

05 The choice of two items at this point is made because of the assumed requirement allowing a container to be overfilled by two items before allowance is made for a further container. Other numbers can of course be chosen to produce differing limit points as required.

10 If the answer at block D31 is "YES" then the routine passes to a function block F58 where the number of containers Nr is incremented by one, that is, $Nr = Nr + 1$. The routine then moves to block F59 where the weight FCW of one standard full container is deducted from y. That is,

15 $y = y - FCW$.

20 The routine then returns to block D31 to repeat the comparison, and the routine continues to loop through blocks D31, F58 and F59 are repeated until the answer at block D31 is "NO".

25 It will be appreciated that each time the routine passes around the loop the counter giving the number of containers is incremented by one, F58, whilst the variable y is reduced by the weight of one full container. When y becomes less than the limiting weight the number of containers is taken as the value then set for Nr and at block F57 the nett weight Wn calculated by subtracting from the gross weight the weight of the calculated number of containers. That

30 is,

$$Wn = Wg - Nr \times Wp$$

35 Having calculated the nett weight Wn the routine then passes to function block F37 where the count

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routine already described hereinbefore proceeds.

It will be appreciated that modifications of and variations in the present invention as described and illustrated may be made. For example, in the
05 embodiment illustrated, only the coin count routine embodies a multiple tare facility. Clearly a similar multiple tare facility could be provided for the note count routine, either as an alternative to, or in addition to, that provided for coins.

10 It will be appreciated that the provision of the functions described above through appropriate software will be within the ability of those skilled in the art and requires no detailed explanation.

15 Many modifications and variations of the invention as specifically described above may be made within the scope of the invention. In particular, the invention may be applied to the weighing and counting of items other than coins or notes, and the items to be counted or weighed need not be representative of money's worth.
20 Furthermore, the apparatus may be arranged to perform routines other than those specifically described.

The multiple tare facility may also be provided independently of the other routines, for example, of the count and verify routines, described above.
25

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CLAIMS

1. Apparatus for determining the number and/or value of items packaged in one or more packages, said
05 apparatus comprising processor means arranged to receive a weight signal representative of the total weight of the packages, said processor means having means for calculating from said weight signal a tare allowance
10 representative of the weight of the packaging of said packages, and means for subtracting the calculated tare allowance from said weight signal to form a nett weight signal representative of the weight of the items.
2. Apparatus as claimed in Claim 1, wherein said means
15 for calculating said tare allowance comprises means for dividing said weight signal by an appropriate preset value to form a quotient, and means for multiplying a preset tare value representative of the weight of the packaging by said quotient to form said tare allowance.
20
3. Apparatus as claimed in Claim 2, wherein said quotient is formed by repeatedly subtracting said preset value from said weight signal, and incrementing a counter for each said subtraction, until said weight
25 signal is smaller than said preset value, and the contents of the counter then providing said quotient.
4. Apparatus as claimed in Claim 2 or 3, wherein the preset value by which said weight signal is divided may
30 be representative of the weight of the items in a single package or of the total weight of one package such that said quotient is at least approximately representative of the number of packages, and said preset tare value is representative of the weight of the packaging of a
35 single package.

5. Apparatus as claimed in any preceding claim,
wherein said processor means further comprises means for
dividing said nett weight signal by an appropriate
weight factor to determine the number and/or value of
said items.

6. Weighing apparatus for determining the number
and/or value of weighed items, said apparatus comprising
means for producing a weight signal, and apparatus as
claimed in any preceding claim for determining the
number and/or value of packaged items and arranged to
receive said weight signal, wherein means are provided
for determining the number and/or value of the weighed
items for said nett weight signal.

7. Weighing apparatus as claimed in Claim 6, wherein
said means for determining the number and/or value of
the weighed items comprises means for dividing said nett
weight signal by an appropriate weight factor.

8. Weighing apparatus as claimed in Claim 6 or 7,
wherein said means for producing the weight signal
comprises weighing means for producing an actual
measured weight.

9. Weighing apparatus as claimed in Claim 7, arranged
to weigh items of different denominations, each
denomination representing a different value, said
weighing apparatus comprising storage means in which a
list of denominations is stored together with the value
assigned to each denomination, and a respective weight
factor for each denomination in the list, wherein each
said weight factor is representative of the weight of a
respective predetermined number of the items of that
denomination.

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10. Weighing apparatus as claimed in Claim 9, wherein said processor means has means for dividing said nett weight signal by a selected weight factor to form a quotient representative of the number of items being weighed, means for comparing said quotient with tolerance limits, and output means for signalling that said quotient is within said tolerance limits and so acceptable or that said quotient is outside said tolerance limits and so unacceptable, and wherein said processor means is arranged to be responsive to said output means signalling that said quotient is acceptable to enable multiplying means to multiply at least part of said quotient by the value assigned to said denomination whereby the value of the weighed items is determined.
11. Weighing apparatus as claimed in Claim 10, wherein when said quotient is acceptable an appropriate exact integer value therefor is formed, and it is said exact integer value which is multiplied by said multiplying means with said assigned value.
12. Weighing apparatus as claimed in any of Claims 6 to 11, comprising a weighing platform for receiving items to be weighed, said means for producing a weight signal being coupled to said weighing platform so that said weight signal is representative of the weight of items on said platform, and input means to which said processor means is responsive to enable the selection of a weighing routine.
13. Weighing apparatus as claimed in Claim 12, wherein said input means comprises a keyboard, and wherein said output means comprises a display.
14. Weighing apparatus as claimed in any of Claims 6 to 13, wherein said processor means comprises a

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microprocessor and said storage means is constituted by at least one memory.

05 15. A method of determining the number and/or value of items packaged in one or more packages, the method comprising the steps of calculating a tare allowance from a weight signal representative of the total weight of the packages, and subtracting the calculated tare allowance from said weight signal to form a nett
10 weight signal representative of the weight of the items.

15 16. A method as claimed in Claim 15, wherein said weight signal is divided by a preset value representative of the weight of said items to form a quotient, and a preset tare value representative of the weight of the packaging is multiplied by said quotient to form said tare allowance.

20 17. Weighing apparatus substantially as hereinbefore described with reference to the accompanying drawings.

25 18. A method of determining the number and/or value of articles substantially as hereinbefore described with reference to the accompanying drawings.

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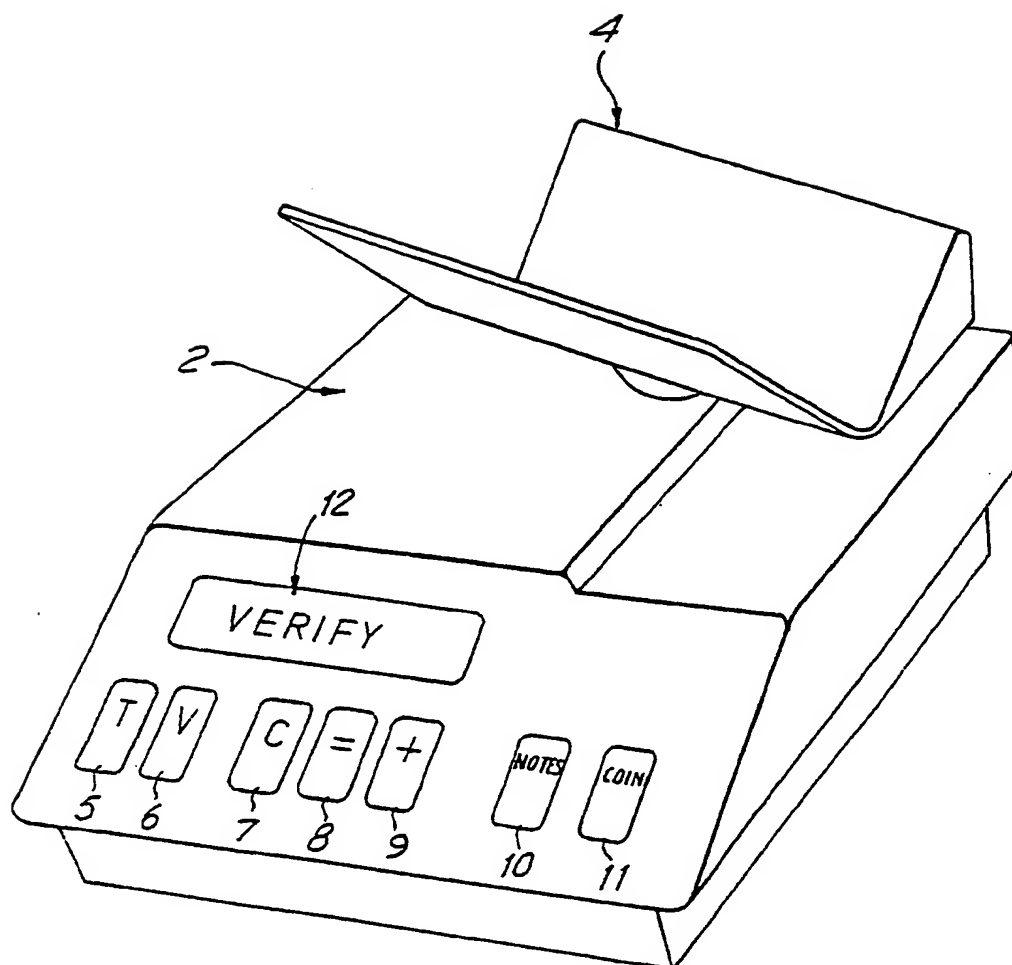
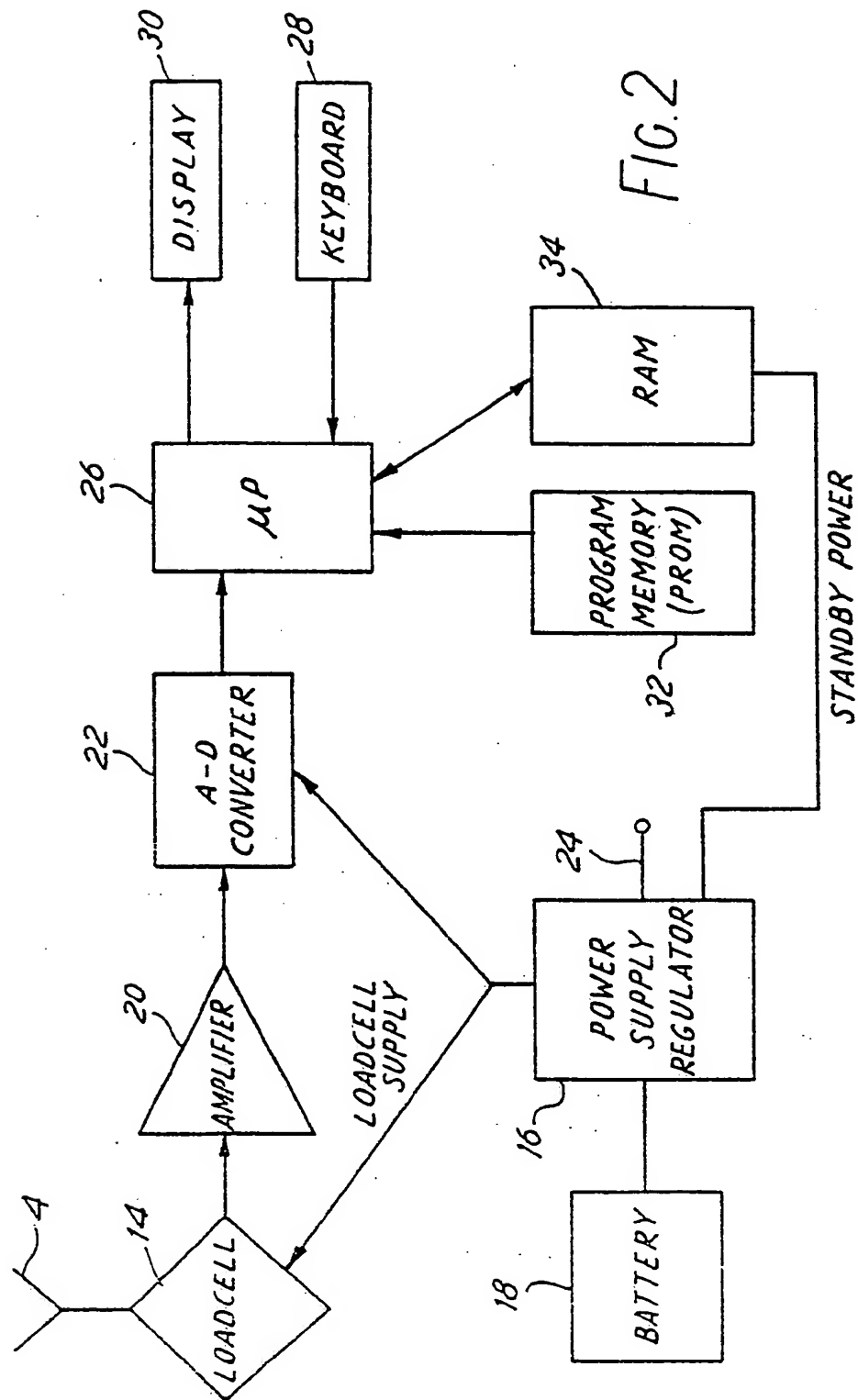
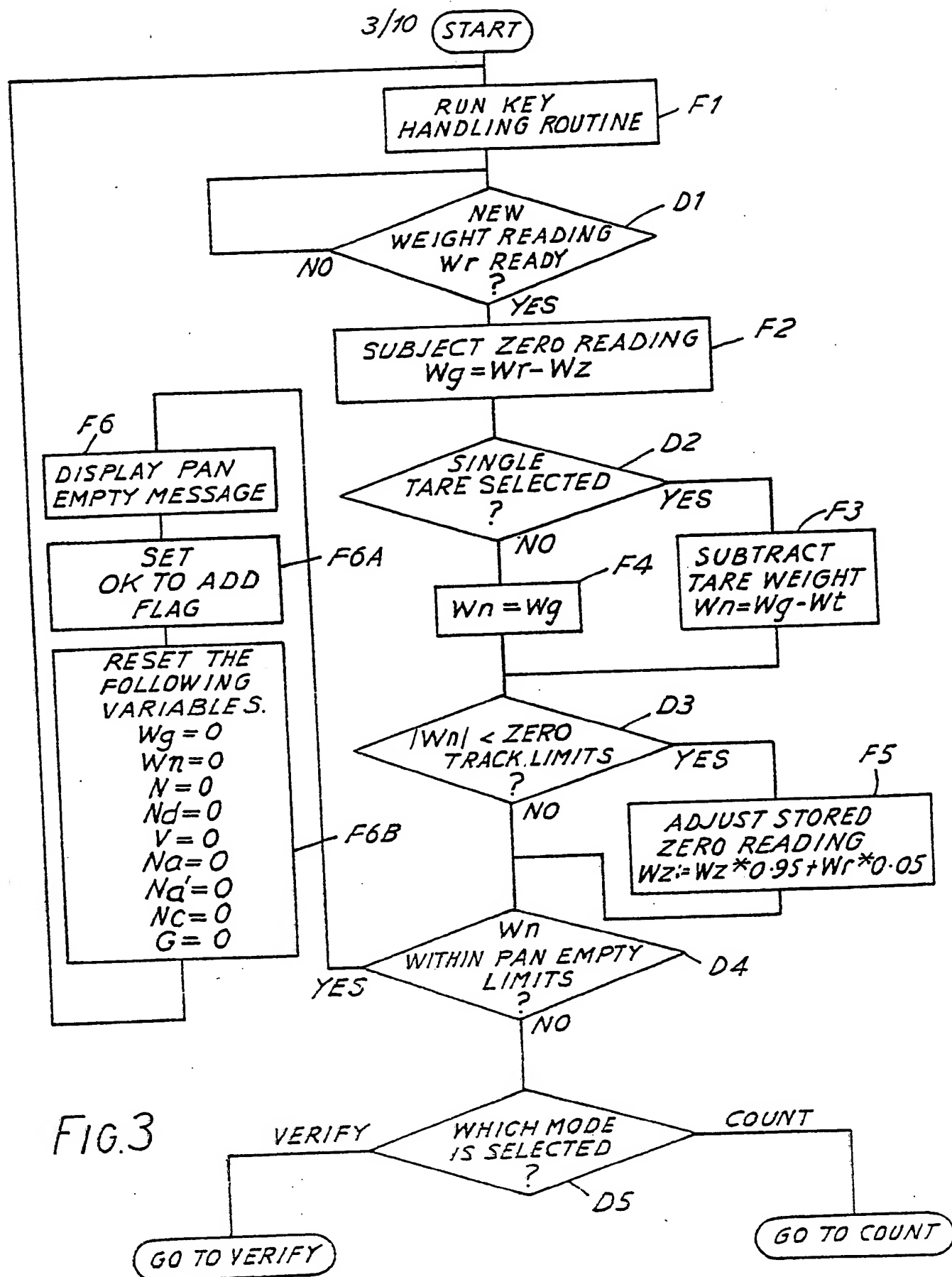


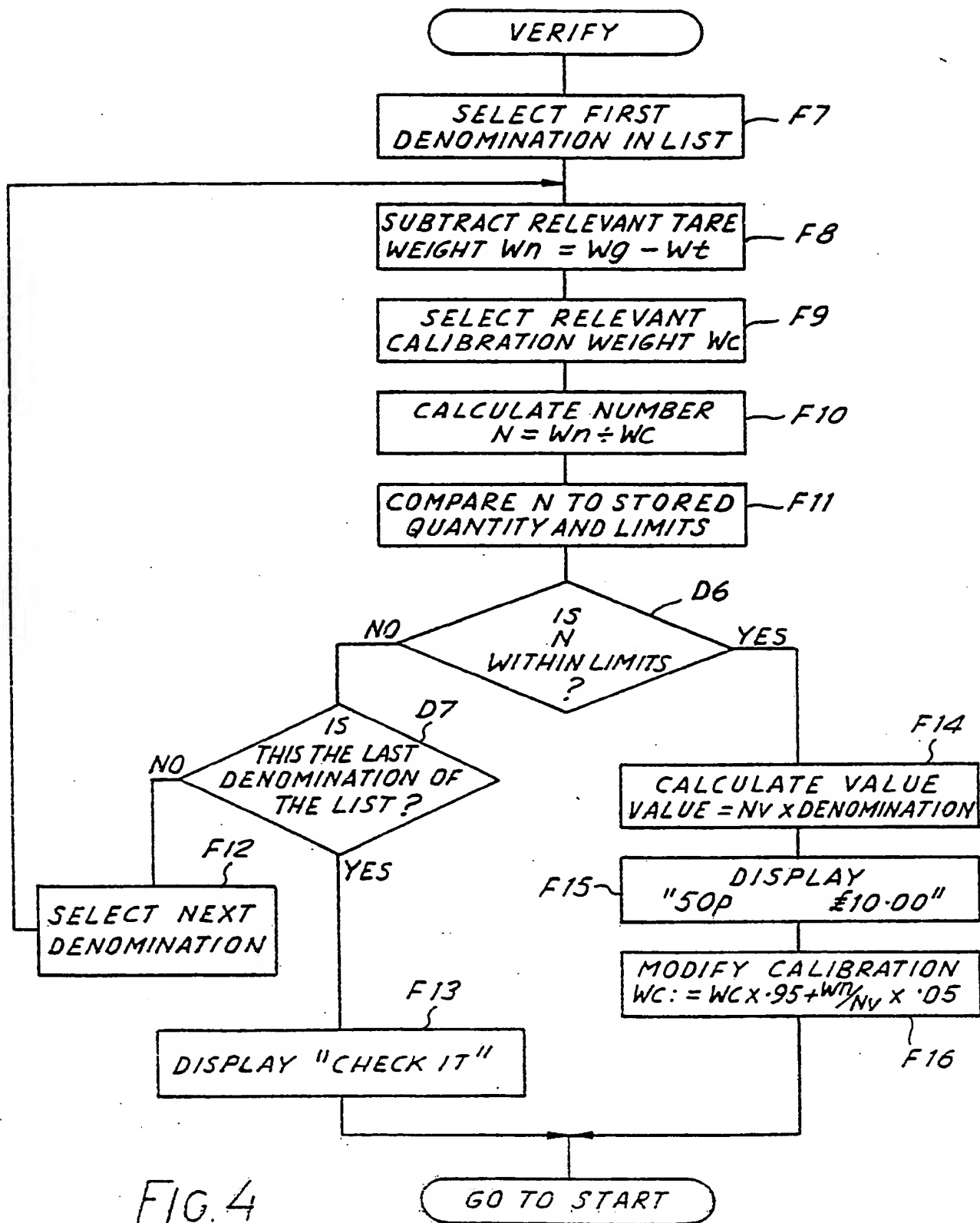
FIG.1

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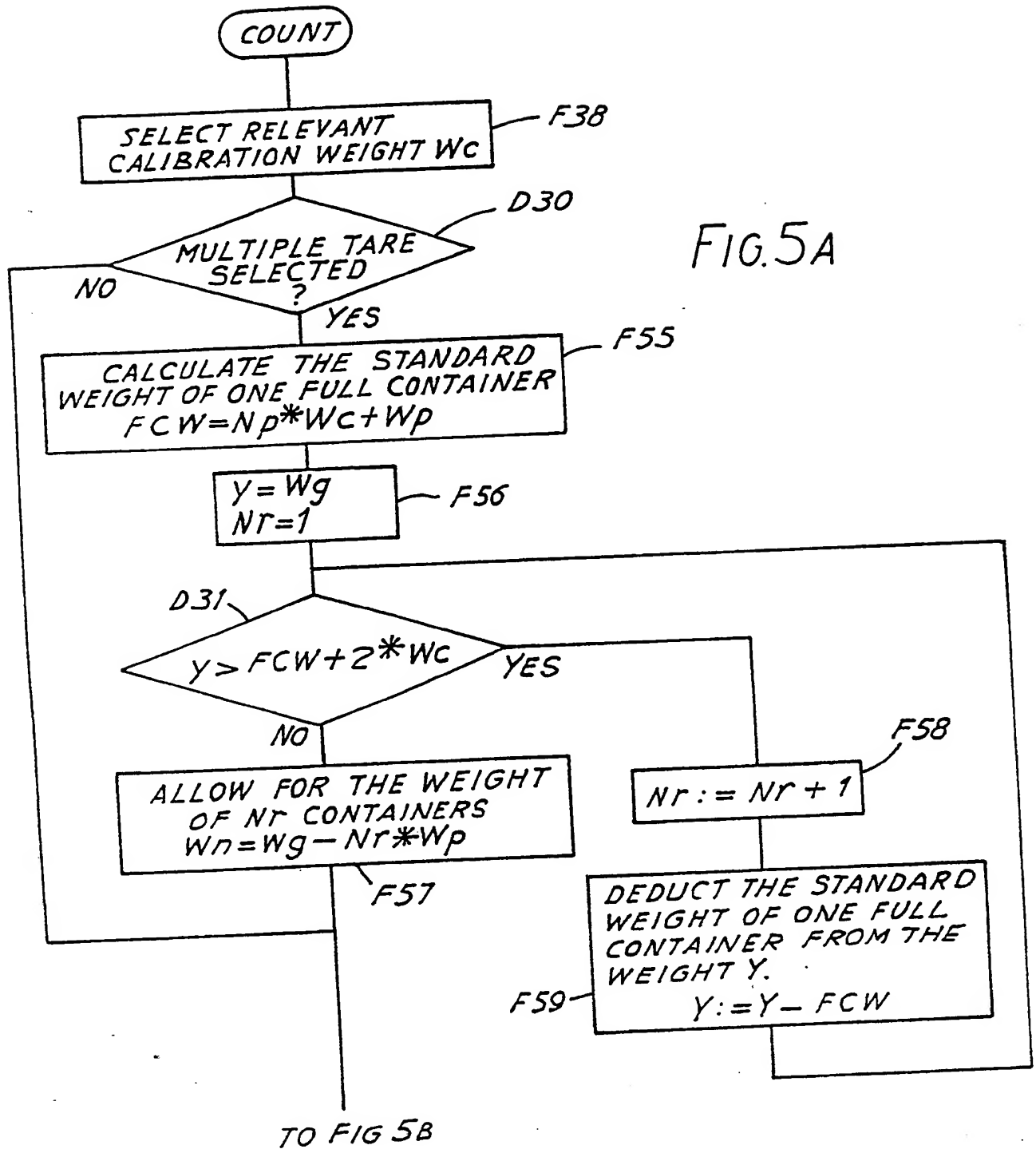




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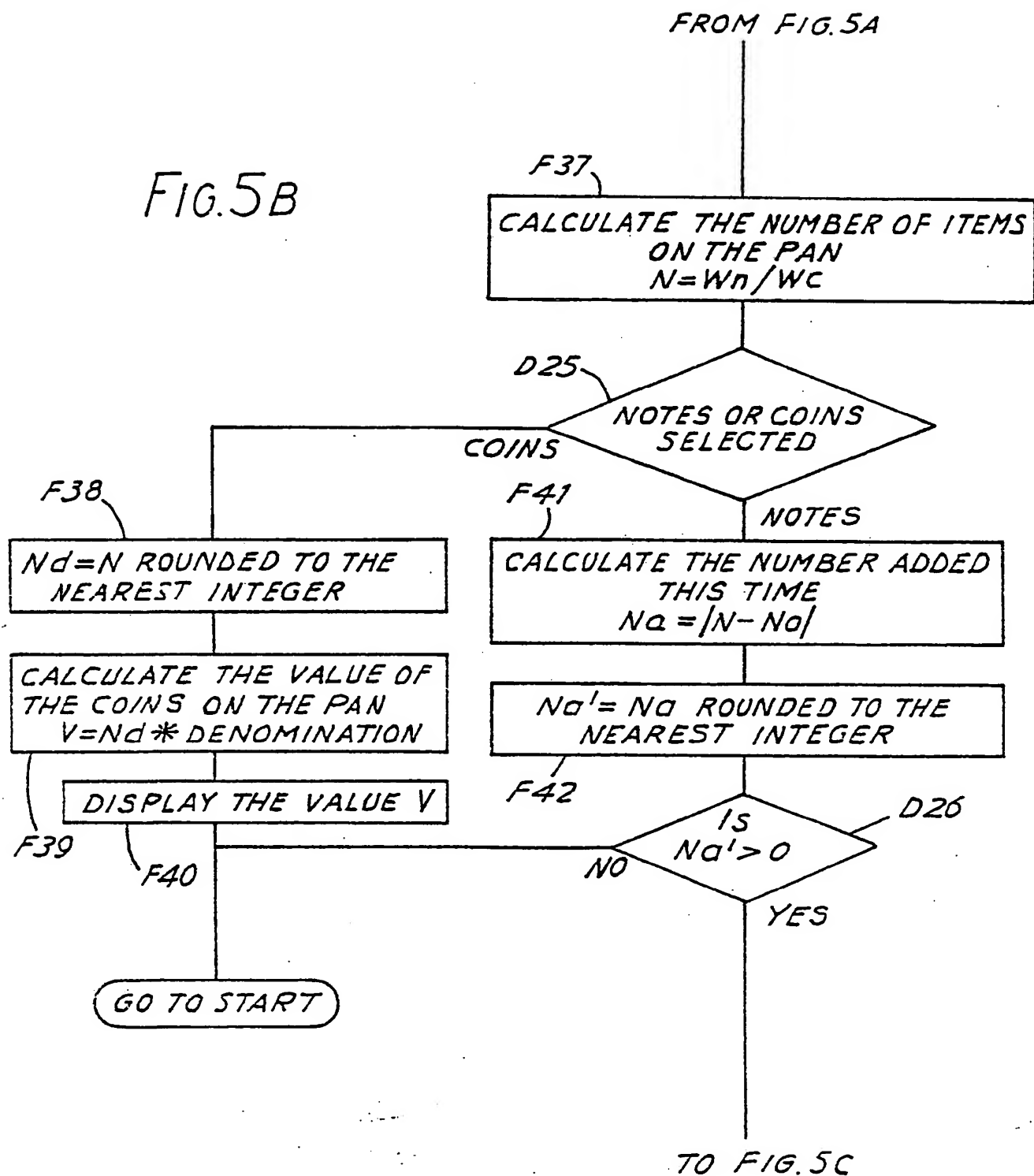


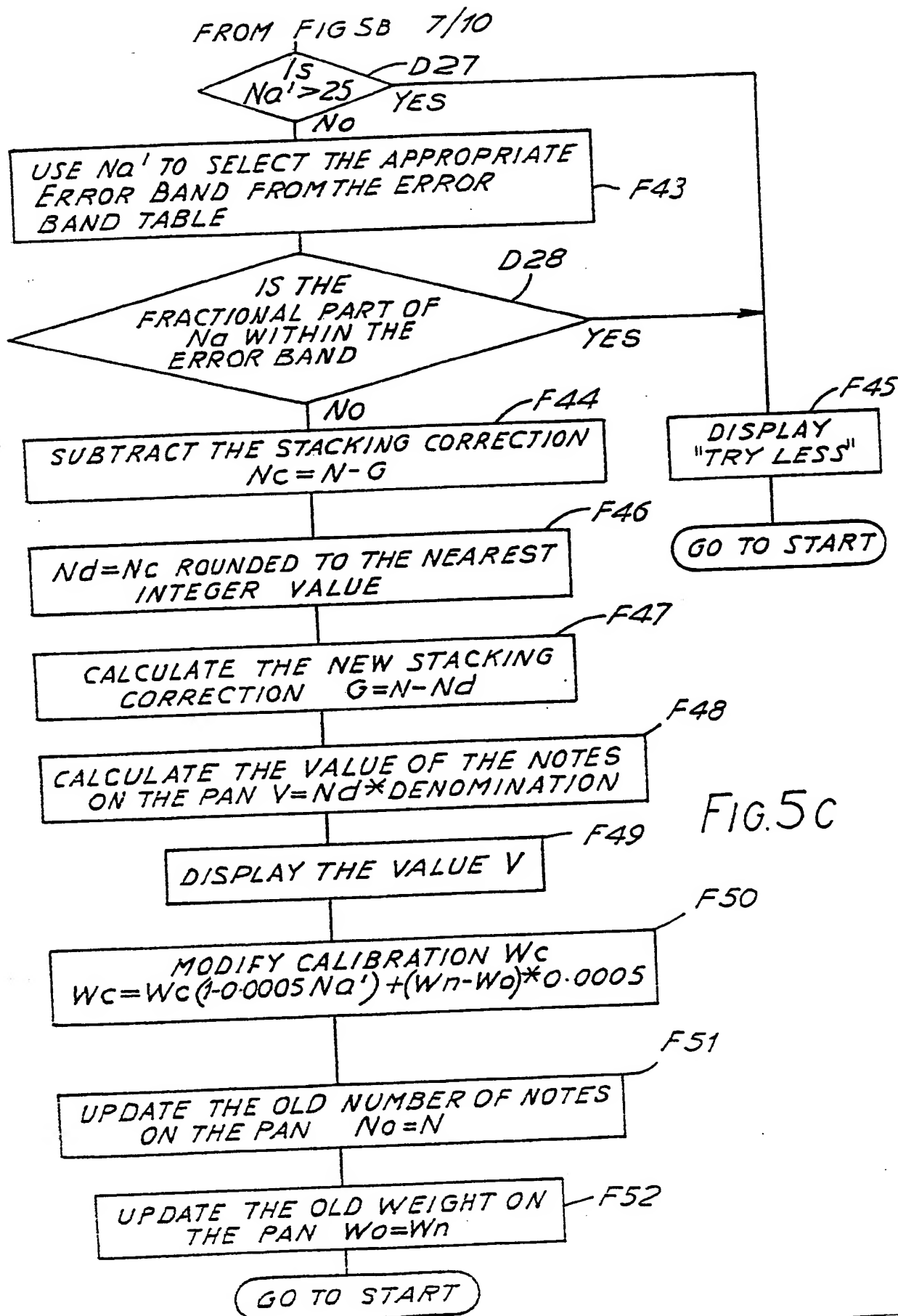
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FIG. 5B





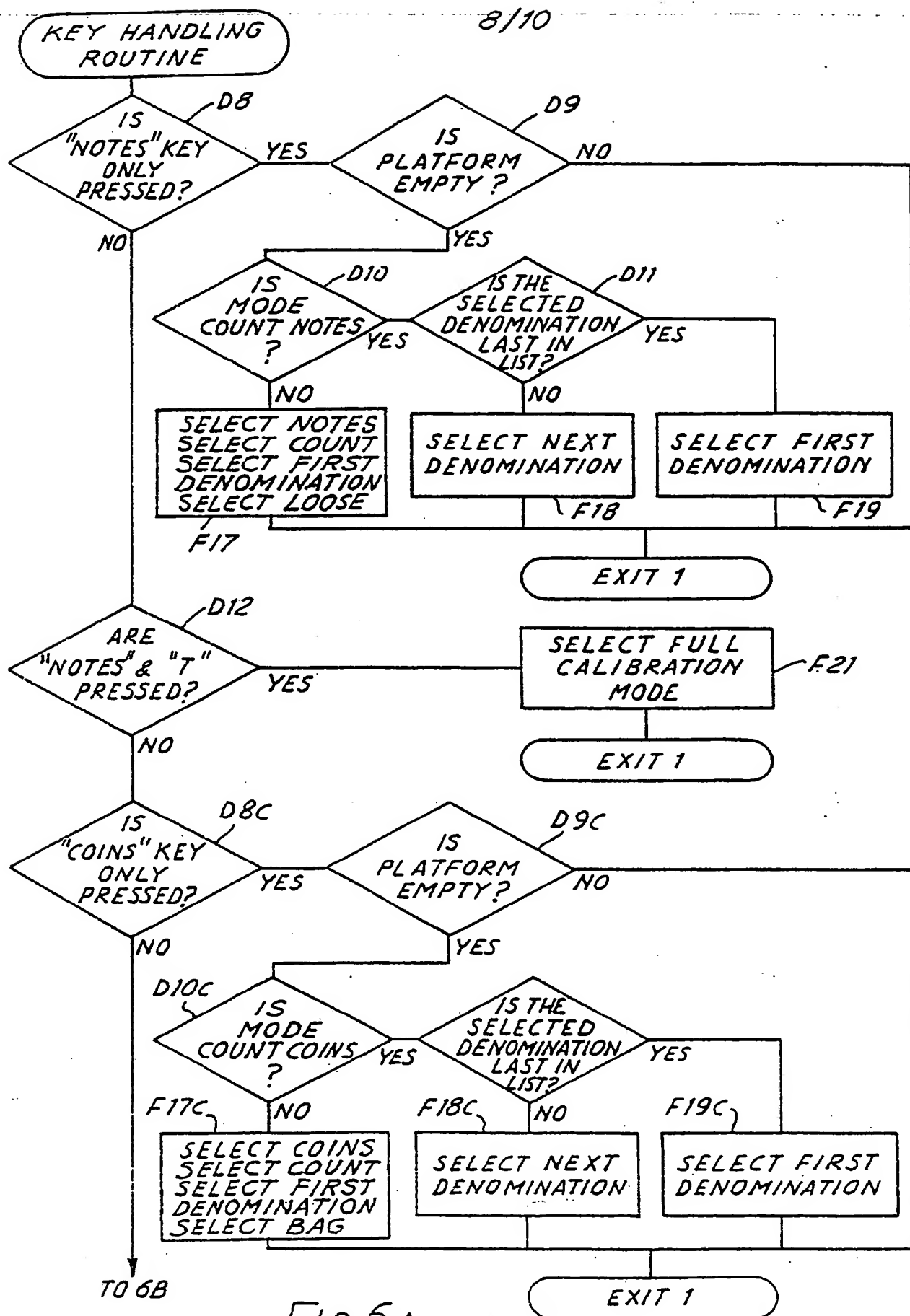


FIG. 6A

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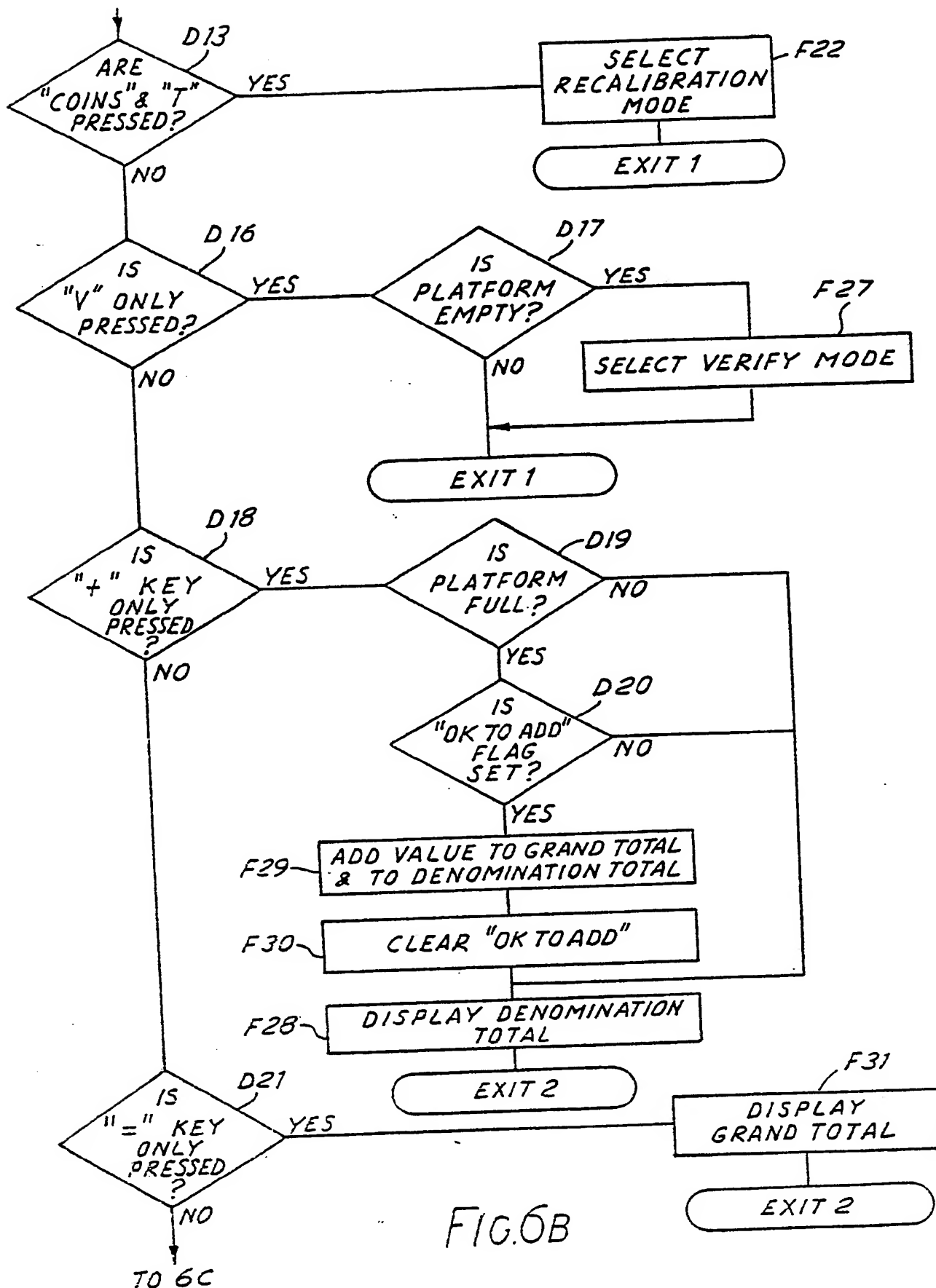


FIG. 6B

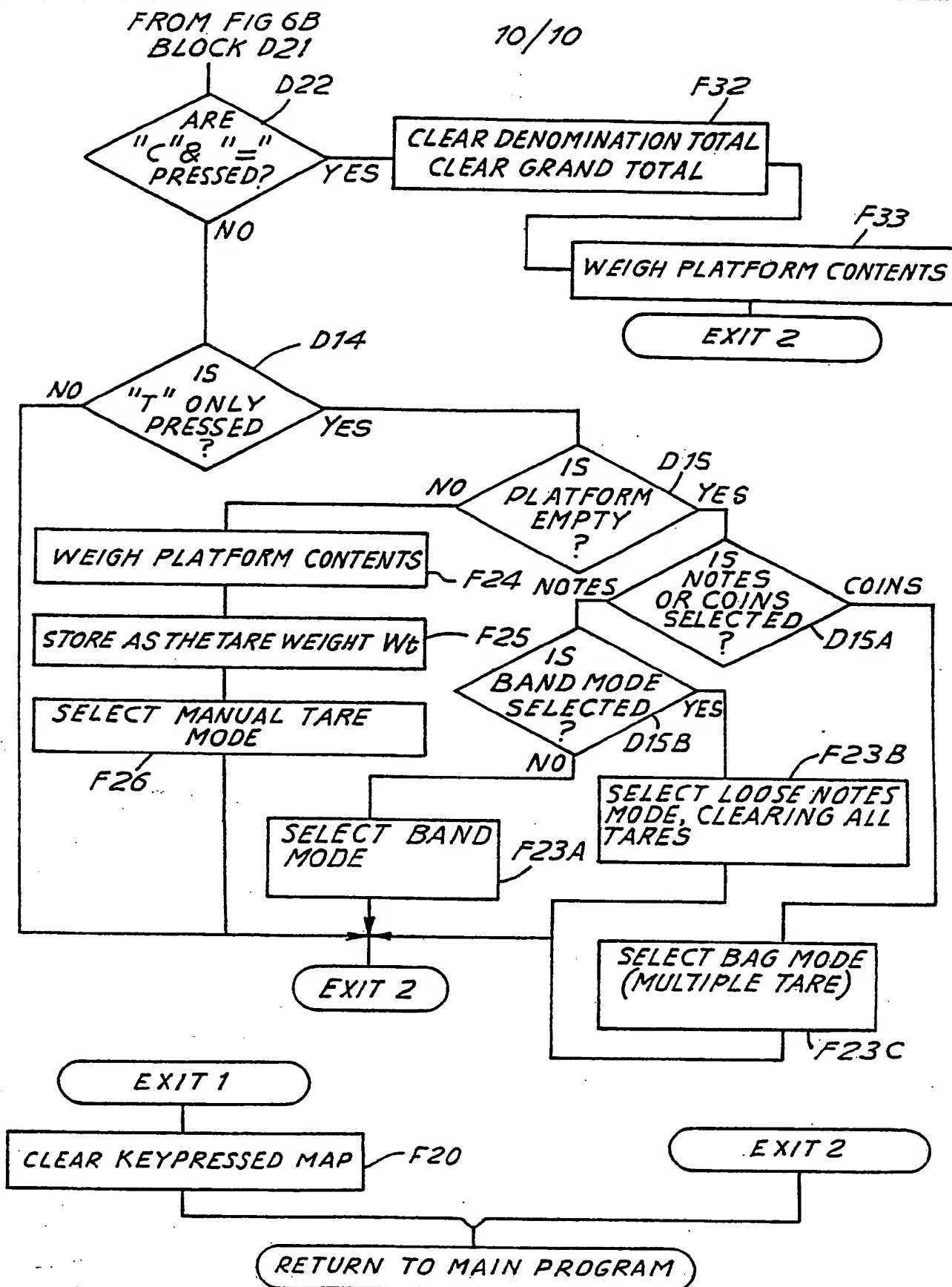
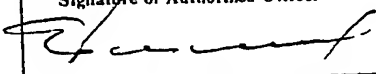


FIG. 6c

INTERNATIONAL SEARCH REPORT

PCT/GB 89/00912

International Application No

| | | |
|--|---|-------------------------------------|
| I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ | | |
| According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl. 5 G01G19/42 ; G01G23/16 | | |
| II. FIELDS SEARCHED | | |
| Minimum Documentation Searched ⁷ | | |
| Classification System | Classification Symbols | |
| Int.Cl. 5 | G01G | |
| Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸ | | |
| | | |
| III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ | | |
| Category ¹⁰ | Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹² | Relevant to Claim No. ¹³ |
| X | US,A,4648056 (J.R. WAKEFIELD) 03 March 1987 see column 1, lines 10 - 16 see column 6, lines 34 - 47 see column 7, lines 48 - 59; figure 4 | 1, 5-7, 15 |
| Y | | 8-10, 12-14 |
| Y | --- WO,A,8809485 (PERCELL GROUP LTD) 01 December 1988 see page 2, lines 20 - 22 see page 3, lines 11 - 15 see page 4, lines 5 - 12 see page 4, line 24 - page 5, line 2; figure 2 (cited in the application) | 8, 9, 12-14 |
| Y | --- EP,A,0040539 (PERKAM LTD) 25 November 1981 see page 2, line 26 - page 3, line 22 (cited in the application) | 10 |
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| IV. CERTIFICATION | | |
| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report | |
| 23 OCTOBER 1989 | 06.12.89 | |
| International Searching Authority | Signature of Authorized Officer | |
| EUROPEAN PATENT OFFICE |  F.M. VRIJDAG | |

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

PCT/GB 89/00912

SA 30451

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20/11/89

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---------------------|----------------------------|---------------------|
| US-A-4648056 | 03-03-87 | CA-A- 1238659 | 28-06-88 |
| WO-A-8809485 | 01-12-88 | None | |
| EP-A-0040539 | 25-11-81 | DE-A- 3176893 | 03-11-88 |
| | | GB-A, B 2076979 | 09-12-81 |
| | | US-A- 4447885 | 08-05-84 |

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